This Page Is Inserted by IFW Operations
and is not a part of the Official Record

BEST AVAILABLE IMAGES

Defective images within this document are accurate representations of the original documents submitted by the applicant.

Defects in the images may include (but are not limited to):

- BLACK BORDERS
- TEXT CUT OFF AT TOP, BOTTOM OR SIDES
- FADED TEXT
- ILLEGIBLE TEXT
- SKEWED/SLANTED IMAGES
- COLORED PHOTOS
- BLACK OR VERY BLACK AND WHITE DARK PHOTOS
- GRAY SCALE DOCUMENTS

IMAGES ARE BEST AVAILABLE COPY.

As rescanning documents *will not* correct images, please do not report the images to the Problem Image Mailbox.

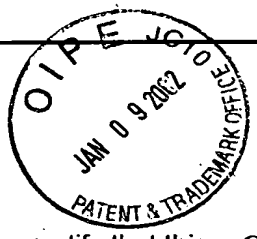
5630

JC07 Rec'd PCT/PTO 09 JAN 2002

CERTIFICATE OF MAILIN[illegible] BY FIRST CLASS MAIL (37 CFR 1.[illegible] Applicant(s): Infineon Technologies AG			Docket No. 6521/83143 #2
Serial No. 09/869,215	Filing Date June 25, 2001	Examiner	Group Art Unit

Invention:

SYSTEM AND METHOD FOR ESTABLISHING AN xDSL DATA TRANSFER LINK



I hereby certify that this **CORRESPONDENCE AND PRIORITY DOCUMENT**
(Identify type of correspondence)

is being deposited with the United States Postal Service as first class mail in an envelope addressed to: The Commissioner of Patents and Trademarks, Washington, D.C. 20231-0001 on **OCTOBER 22, 2001**
(Date)

Gerald T. Shekleton
(Typed or Printed Name of Person Mailing Correspondence)

Gerald T. Shekleton
(Signature of Person Mailing Correspondence)

Note: Each paper must have its own certificate of mailing.

OIPE JC10 JAN 0 3 2002 PATENT & TRADEMARK OFFICE

83143NT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In Re U.S. Patent Application		)
Applicant:	Infineon Technologies AG	)
Serial No.:	09/869,215	)
Filed:	June 25, 2001	)
For:	**System and Method For Establishing an xDSL Data Transfer Link**	)
Examiner:		)
Art Unit:		)

CORRESPONDENCE

Assistant Commissioner for Patents
Washington, D.C. 20231

Sir:

Enclosed is the certified copy of European application no. PCT/EP01/01559 thereby perfecting Applicant's claim for priority herein.

Respectfully submitted,

WELSH & KATZ, LTD.

By
Gerald T. Shekleton
Registration No. 27,466

Date: October 22, 2001
WELSH & KATZ, LTD.
120 South Riverside Plaza, 22nd Floor
Chicago, Illinois 60606-3913
Telephone: 312/655-1500

Europäisches Patentamt | European Patent Office | Office européen des vets

OIPE JC10 JAN 09 2002 PATENT & TRADEMARK OFFICE

Bescheinigung | Certificate | Attestation

Die angehefteten Unterlagen stimmen mit der ursprünglich eingereichten Fassung der auf dem nächsten Blatt bezeichneten internationalen Patentanmeldung überein.

The attached documents are exact copies of the international patent application described on the following page, as originally filed.

Les documents fixés à cette attestation sont conformes à la version initialement déposée de la demande de brevet international spécifiée à la page suivante.

Den Haag, den
The Hague,
La Haye, le 26. 09. 2001

Der Präsident des Europäischen Patentamts
Im Auftrag
For the President of the European Patent Office
Le Président de l'Office européen des brevets
p.o.

H.A.M.W. ter Haar

Patentanmeldung Nr.
Patent application no.
Demand de brevet n° PCT/EP 01/01559

Box No.V DESIGNATIO! STATES

The following designations are hereoy made under Rule 4.9(a) *(mark the applicable check-boxes; at least one must be marked)*:

Regional Patent

☒ **AP** **ARIPO Patent:** **GH** Ghana, **GM** Gambia, **KE** Kenya, **LS** Lesotho, **MW** Malawi, **MZ** Mozambique, **SD** Sudan, **SL** Sierra Leone, **SZ** Swaziland, **TZ** United Republic of Tanzania, **UG** Uganda, **ZW** Zimbabwe, and any other State which is a Contracting State of the Harare Protocol and of the PCT

☒ **EA** **Eurasian Patent:** **AM** Armenia, **AZ** Azerbaijan, **BY** Belarus, **KG** Kyrgyzstan, **KZ** Kazakhstan, **MD** Republic of Moldova, **RU** Russian Federation, **TJ** Tajikistan, **TM** Turkmenistan, and any other State which is a Contracting State of the Eurasian Patent Convention and of the PCT

☒ **EP** **European Patent:** **AT** Austria, **BE** Belgium, **CH and LI** Switzerland and Liechtenstein, **CY** Cyprus, **DE** Germany, **DK** Denmark, **ES** Spain, **FI** Finland, **FR** France, **GB** United Kingdom, **GR** Greece, **IE** Ireland, **IT** Italy, **LU** Luxembourg, **MC** Monaco, **NL** Netherlands, **PT** Portugal, **SE** Sweden, **TR** Turkey, and any other State which is a Contracting State of the European Patent Convention and of the PCT

☒ **OA** **OAPI Patent:** **BF** Burkina Faso, **BJ** Benin, **CF** Central African Republic, **CG** Congo, **CI** Côte d'Ivoire, **CM** Cameroon, **GA** Gabon, **GN** Guinea, **GW** Guinea-Bissau, **ML** Mali, **MR** Mauritania, **NE** Niger, **SN** Senegal, **TD** Chad, **TG** Togo, and any other State which is a member State of OAPI and a Contracting State of the PCT *(if other kind of protection or treatment desired, specify on dotted line)* .....

National Patent *(if other kind of protection or treatment desired, specify on dotted line)*:

☒ **AE** United Arab Emirates
☒ **AG** Antigua and Barbuda
☒ **AL** Albania
☒ **AM** Armenia
☒ **AT** Austria
☒ **AU** Australia
☒ **AZ** Azerbaijan
☒ **BA** Bosnia and Herzegovina
☒ **BB** Barbados
☒ **BG** Bulgaria
☒ **BR** Brazil
☒ **BY** Belarus
☒ **BZ** Belize
☒ **CA** Canada
☒ **CH and LI** Switzerland and Liechtenstein
☒ **CN** China
☒ **CR** Costa Rica
☒ **CU** Cuba
☒ **CZ** Czech Republic
☒ **DE** Germany
☒ **DK** Denmark
☒ **DM** Dominica
☒ **DZ** Algeria
☒ **EE** Estonia
☒ **ES** Spain
☒ **FI** Finland
☒ **GB** United Kingdom
☒ **GD** Grenada
☒ **GE** Georgia
☒ **GH** Ghana
☒ **GM** Gambia
☒ **HR** Croatia
☒ **HU** Hungary
☒ **ID** Indonesia
☒ **IL** Israel
☒ **IN** India
☒ **IS** Iceland
☒ **JP** Japan
☒ **KE** Kenya
☒ **KG** Kyrgyzstan
☒ **KP** Democratic People's Republic of Korea
☒ **KR** Republic of Korea
☒ **KZ** Kazakhstan
☒ **LC** Saint Lucia
☒ **LK** Sri Lanka
☒ **LR** Liberia
☒ **LS** Lesotho
☒ **LT** Lithuania
☒ **LU** Luxembourg
☒ **LV** Latvia
☒ **MA** Morocco
☒ **MD** Republic of Moldova
☒ **MG** Madagascar
☒ **MK** The former Yugoslav Republic of Macedonia
☒ **MN** Mongolia
☒ **MW** Malawi
☒ **MX** Mexico
☒ **MZ** Mozambique
☒ **NO** Norway
☒ **NZ** New Zealand
☒ **PL** Poland
☒ **PT** Portugal
☒ **RO** Romania
☒ **RU** Russian Federation
☒ **SD** Sudan
☒ **SE** Sweden
☒ **SG** Singapore
☒ **SI** Slovenia
☒ **SK** Slovakia
☒ **SL** Sierra Leone
☒ **TJ** Tajikistan
☒ **TM** Turkmenistan
☒ **TR** Turkey
☒ **TT** Trinidad and Tobago
☒ **TZ** United Republic of Tanzania
☒ **UA** Ukraine
☒ **UG** Uganda
☒ **US** United States of America
☒ **UZ** Uzbekistan
☒ **VN** Viet Nam
☒ **YU** Yugoslavia
☒ **ZA** South Africa
☒ **ZW** Zimbabwe

Check-box reserved for designating States which have become party to the PCT after issuance of this sheet:

☐

Precautionary Designation Statement: In addition to the designations made above, the applicant also makes under Rule 4.9(b) all other designations which would be permitted under the PCT except any designation(s) indicated in the Supplemental Box as being excluded from the scope of this statement. The applicant declares that those additional designations are subject to confirmation and that any designation which is not confirmed before the expiration of 15 months from the priority date is to be regarded as withdrawn by the applicant at the expiration of that time limit. *(Confirmation (including fees) must reach the receiving Office within the 15-month time limit.)*

See Notes to the request form

Description

System and method for establishing an xDSL data transfer link

The invention relates to a system and a method for establishing a data transfer link between an xDSL user modem and a corresponding xDSL modem within a central office.

Fig. 1 shows a conventional xDSL system with several xDSL user modems, each connected via a telephone line to a corresponding xDSL modem within the central office. In a normal operation, the conventional xDSL modem within the central office is operating continuously and tries to establish a data transfer link with the corresponding remote user xDSL modem connected via a telephone line. When the user xDSL modem is ready for data transfer, a data link is established by means of a start-up procedure. A central office comprises a very large number of xDSL modems connecting the users of the telephone network. The disadvantage of the conventional xDSL system as shown in Fig. 1 is that the xDSL modems within the central office continuously try to establish a connection with the corresponding user xDSL modem and therefore consume much power. An xDSL modem within a central office consumes up to 1,5 Watt of power. Since the number of xDSL modems within a central office can be very large, the power consumption of all xDSL modems is significant.

Accordingly, it is the object of the present invention to provide a method and a system for data transfer between an xDSL user modem and a corresponding xDSL modem within a central office which consume a minimum amount of power.

This object is achieved by a method for establishing a data transfer link between an xDSL user modem and a corresponding xDSL modem within a central office having the features of

claim 1 and by an xDSL data transfer system having the features of patent claim 8.

The present invention provides a method for establishing a data transfer link between an xDSL user modem and the corresponding xDSL modem within the central office comprising the following steps:
generating a wake-up bit pattern identifying the user modem,
pulse length modulating the generated wake-up bit pattern to generate a pulse length modulated wake-up signal,
transmitting the pulse length modulated wake-up signal from the user xDSL modem via a data transfer medium to the corresponding xDSL modem within the central office,
demodulating the transmitted wake-up signal by the xDSL modem within the central office,
comparing the demodulated wake-up signal with a stored wake-up bit pattern for the detection of a transmission of the wake-up bit pattern,
generating a wake-up command signal for switching the xDSL modem within the central office from a sleep mode to an operation mode for data transfer, when the wake-up bit pattern is detected.

In the sleep mode, the power consumption of the xDSL modem within the central office is low, thus minimizing the overall power consumption within the central office.

In a preferred embodiment of the method according to the present invention, the xDSL modem within the central office commences a start-up procedure, when it is switched to the operation mode.

In a further embodiment, the wake-up signal is transmitted periodically by the xDSL user modem.

In a further embodiment, the xDSL modem within the central office is switched from the operation mode to the sleep mode when the data transfer is finished.

In a further preferred embodiment, a detection counter is incremented when the wake-up bit pattern is detected.

In a further preferred embodiment, a wake-up command signal is generated when the detection counter reaches a predetermined threshold value.

In a preferred embodiment, the threshold value for the detection counter is adjusted.

The invention provides further an xDSL data transfer system for data transfer comprising at least one xDSL user modem connected via a data transfer medium to a corresponding xDSL modem within the central office,
wherein the xDSL user modem generates a wake-up signal for switching the corresponding the xDSL modem within the central office from a sleep mode to an operation mode.

In a preferred embodiment, the wake-up signal is pulse-length modulated.

In a preferred further embodiment, the xDSL user modem comprises
generating means for generating a wake-up pattern identifying the xDSL user modem, and
modulating means for pulse length modulation of the wake-up pattern to generate a pulse length modulation wake-up signal, wherein the pulse length modulated wake-up signal has a spectrum within the xDSL upstream frequency band.

In a preferred embodiment of the xDSL data transfer system according to the present invention, the generated wake-up bit pattern comprises 16 bits.

In a further embodiment, each bit of the wake-up bit pattern determines the duration of a pulse in the pulse length modulated signal.

In a still further embodiment, the level of the wake-up signal is less than a predetermined maximum PSD-signal level.

In a further embodiment of the xDSL data transfer system according to the present invention, the xDSL modem within the central office comprises
demodulating means for demodulating the received analog pulse length modulated signal,
storing means for storing a wake-up bit pattern which identifies a user modem,
detecting means for detecting the demodulated wake-up bit pattern by comparing the demodulated received signal with the stored wake-up bit pattern,
wake-up command generating means for generating a wake-up command to switch the xDSL modem from the sleep mode to the operation mode, when the received wake-up bit pattern is identical with the stored wake-up bit pattern.

In a further embodiment of the xDSL data transfer system according to the present invention, the demodulating means of the xDSL modem comprises a gain sequencer for amplifying the received analog signal with an adjustable gain,
rectifying means for rectifying the amplified signal,
a low-pass filter for filtering the rectified signal, and
a comparator for comparing the filtered signal with an adjustable threshold generating an asynchronous pulse train supplied to the detecting means.

In a preferred embodiment of the xDSL data transfer system according to the present invention, the detecting means comprises

a synchronization means for synchronizing the asynchronous pulse train with an internal clock signal,
a pulse length detecting circuit for detecting the pulse length of each pulse in the synchronized pulse train,
a bit pattern generating means for generating a bit pattern depending on the detected pulse length,
a register for temporarily storing the received bit pattern,
a comparator which compares the received bit pattern with the stored wake-up bit pattern and which increments a counter when the received bit pattern and the stored wake-up bit pattern is identical.

In a preferred embodiment of the xDSL system according to the present invention, the wake-up command generating means generates the wake-up command when the counter reaches a predetermined threshold value.

In a preferred embodiment of the xDSL system according to the present invention the xDSL modems are VDSL modems.

In a preferred embodiment of the xDSL data transfer system, the data transfer medium is a telephone line.

The invention provides further an xDSL user modem comprising
a generating means for generating a wake-up pattern identifying the xDSL user modem, and
a modulating means for pulse length modulation of the wake-up bit pattern to generate the pulse length modulated wake-up signal,
wherein the pulse length modulated wake-up signal has a spectrum within the xDSL upstream frequency band.

The invention provides further an xDSL central office modem within a central office comprising
demodulating means for the demodulation of a received analog pulse length modulated signal,

storing means for storing a wake-up bit pattern which identifies the user modem connected to the xDSL office modem via a data transfer medium,
detecting means for detecting a demodulated wake-up bit pattern by comparing the demodulated received signal with the stored wake-up bit pattern,
a wake-up command generating means for generating a wake-up command to switch the xDSL modem from the sleep mode to the operation mode when the received wake-up bit pattern is identical with the stored wake-up pattern.

In the following description, a preferred embodiment of a method for establishing a data transfer link and an xDSL data transfer system for data transfer according to the present invention is described with reference to the drawings.

Fig. 1 shows an xDSL data transfer system for data transfer according to the state of the art;

Fig. 2 shows an xDSL data transfer system for data transfer according to the present invention;

Fig. 3 shows a block diagram of additional units within an xDSL user modem according to the present invention;

Fig. 4 shows a block diagram of an xDSL modem within the central office according to the present invention;

Fig. 5 shows demodulating means of an xDSL modem within the central office according to the present invention;

Fig. 6 shows a block diagram of detecting means of the xDSL modem within the central office according the present invention;

Fig. 7 shows a timing diagram of the pulse length modulated wake-up signal according to the present invention;

Fig. 8a, b show a flow diagram of the generation of a wake-up command signal by an xDSL modem within the central office according to the present invention.

The xDSL data transfer system 1 for data transfer according to the present invention is shown in Fig. 2. The xDSL data transfer system comprises N data sources 2-1 to 2-N, each generating a data upstream signal. The data upstream signal is supplied via signal lines 3-1 to 3-N to the corresponding xDSL user modem 4-1 to 4-N. The xDSL user modem 4 consists of a conventional xDSL modem 5 which is connected on its output side via a line 6 to a wake-up signal generating unit 7 which generates a wake-up signal. The xDSL user modem 4 is connected via a physical medium, e.g. a twisted telephone line, to a corresponding xDSL modem 9 within a central office 10. Each xDSL modem 9 of the central office 10 comprises a conventional xDSL modem 11 and a wake-up signal detection unit 12 for detecting a wake-up signal received via the telephone line 8. The wake-up signal detection unit 12 is connected to the telephone 8 via line 13 and sends a wake-up command signal via a control line 14 to the xDSL modem 11 to switch the xDSL modem from a sleep mode to an operation mode for data reception.

The wake-up signal generating unit 7 of the xDSL user modem 4 generates a wake-up signal via the telephone line 8 to its corresponding xDSL modem 9 within the central office 10. The transmitted wake-up signal is detected by the wake-up signal detection unit 12 so that the xDSL modem 11 is switched from a sleep mode to an operation mode for data transfer. Each user modem 4 generates a wake-up signal which is unique to the user modem 4 so that the wake-up signal detection unit 12 is insensitive to far end cross-talk (FEXT) between different telephone lines 8. The unique wake-up signal for each user modem 4 guarantees that erroneous wake-ups of other xDSL-modems as a consequence of far end cross-talk (FEXT) are

prevented. Accordingly, the different telephone lines 8-1 to 8-N can be arranged in a common telephone cable 15.

When an xDSL user modem 4 is inactive, the corresponding xDSL modem 9 within the central office 10 is in a sleep mode. Since a data source 2 like a personal computer 2 normally does not send a data upstream signal to the central office for the most part of the day, the corresponding xDSL modem 9 within the central office 10 is in the sleep mode for most of the time. In the sleep mode, the xDSL modem 9 consumes only a minimum necessary amount of electrical power. The xDSL modem 9 is switched to the power-consuming operation mode only when the wake-up signal from the corresponding xDSL user modem 4 is detected. When the user turns on the power of the user modem 4 and wishes to establish a data connection, the user modem 4 generates a wake-up signal and sends it via the telephone line 8 to the corresponding xDSL modem 9 in the central office. The wake-up signal detection unit 12 detects a received wake-up signal and switches the xDSL modem 9 to an operation mode. The xDSL modem 9 then commences a start-up procedure. When the user ends the data connection, the xDSL modem 9 within the central office 10 is switched back to the sleep mode.

Fig. 3 shows a wake-up signal generating unit 7 within an xDSL user modem 4 according to the present invention. The wake-up signal generating unit 7 comprises a wake-up pattern generating means 16 for generating a wake-up bit pattern identifying the xDSL user modem 4. The generated wake-up bit pattern is supplied via a line 17 to a modulation means 18. The modulation means 18 performs a pulse length modulation of the upstream data signal supplied from the data source 2 via data line 6. The upstream data signal is pulse length modulated with the wake-up bit pattern to generate a pulse length modulated wake-up signal which is transmitted via line 8 to the corresponding xDSL modem 9 within the central office 10. The pulse length modulated wake-up signal has a frequency

range within the xDSL upstream frequency band. For a VDSL application, the upstream frequency band is between 3,5 MHz and 5 MHz. The generated wake-up signal can pass through passive magnetic elements such as transformers, and does not get blocked before it reaches the wake-up detection unit 12 within the xDSL modem 9 in the central office 10.

In a preferred embodiment, the wake-up bit pattern generating means 16 generates a wake-up bit pattern which comprises 16 bits. This comparatively short bit pattern ensures that the wake-up process is completed within a relatively short time, e.g. within 100 milliseconds.

Fig. 7 shows an example for a wake-up signal generated by the wake-up generating means 7 of a user xDSL modem 4. The wake-up signal has a flat frequency spectrum in the xDSL upstream frequency band modulated by a duty cycle modulation. A sequence of N bits each of a duration of d microseconds is transmitted periodically by the user modem 4 until it is detected by the wake-up detection unit 12 within the xDSL modem 9 of the central office 10. Each bit of the wake-up bit pattern is represented by a pulse of d_{on} microseconds on and d_{off} microseconds off, where $d_{on} < d_{off}$, if the bit is logical low, and $d_{on} > d_{off}$, if the bit is logical high. In a preferred embodiment, the wake-up bit pattern comprises 16 bits, duration d is approximately 100 microseconds, wherein $d_{on} = 0,25\ d$, when the bit is logical low, and $d_{on} = 0,75\ d$, when the bit is logically high. Fig. 7 shows an example for a wake-up signal during one period of the wake-up signal. Fig. 7 shows only the signal envelope. The signal itself is a random noise signal whose spectrum coincides with the spectrum of a standard xDSL upstream signal.

Fig. 4 shows a block diagram of the wake-up signal detection unit 12 within an xDSL modem 9 of the central office 10. The wake-up signal detection unit 12 comprises demodulating means 19 for demodulating the received analog pulse length

modulated signal. The demodulating means 19 are connected via a line 20 to comparing means 21 which compare the demodulated received bit pattern with the wake-up bit pattern stored within storing means 22. The storing means 22 store a wake-up bit pattern which identifies the corresponding user modem 4. The storing means 22 are connected to the comparing means 21 via a line 23. If the comparator 22 detects that the demodulated bit pattern is identical with the stored wake-up bit pattern, it sends a detection signal via a line 24 to a wake-up command generating means 25 which generates the wake-up command and transmits the wake-up command via a control line 14 to the corresponding modem 11. The wake-up command switches the xDSL modem 9 from the sleep mode to the operation mode. The wake-up signal detection unit 12 can be implemented by a simple circuitry that does not require large power. Accordingly, the power consumption of the wake-up signal detection unit 12 is only a small percentage of the power consumed by the complete xDSL modem 9. The wake-up signal detection unit is insensitive to the absolute power level of the received wake-up signal in order to accommodate all line distances. The wake-up signal detection unit 12 is provided for detecting a bit pattern, not a signal energy.

Fig. 5 shows a preferred embodiment of the demodulating means 19 within the wake-up detection unit 12 according to the present invention. The demodulating means 19 comprises a gain sequencer 26 for amplifying the received analog signal with an adjustable gain, the rectifying circuit 27 rectifying the amplified signal, a low-pass filter 28 for filtering the rectified signal and a comparator 29 for comparing the filtered signal with an adjustable threshold generating an asynchronous pulse train supplied to the detecting means 21. The gain sequencer 26 amplifies the incoming wake-up signal and comprises an operation amplifier 30, resistors 31a, 31b and adjustable resistors 32a, 32b. The gain sequencer 26 amplifies the incoming wake-up signal with an increasing gain until the wake-up signal is detected by the wake-up detection

means. The rectifying means 27 comprising an operational control amplifier 33 which controls switches 34a, 34b supplies a rectified signal to the following low-pass filter 28. The low-pass filter 28 shown in Fig. 5 removes the high frequency noise and tracks the signal envelope of the received wake-up signal. The low-pass filter 28 further removes residual DC signal components. The low-pass filter 28 is an active filter comprising an operational amplifier 35, resistors 36, 37, 38 and capacitors 39, 40. The output of the operational amplifier 35 is connected via line 41 to comparing means 29 including a comparator 42, a resistor 43a and a capacitor 44a.

The output of the comparator 42 is connected via line 20 to the bit pattern comparing means 21 comparing the output bit pattern of the comparator 42 with the stored wake-up bit pattern. The bit pattern comparing means 21 generates a detecting signal with the received bit pattern output by a comparator 42 which is identical with the wake-up bit pattern stored in the storage means 22 and sends the detecting signal to the wake-up command generating means 25.

Fig. 6 shows a preferred embodiment of the bit pattern detecting means 21. The bit pattern detecting means 21 comprises a synchronization circuit 43 for synchronizing the asynchronous pulse train received from the demodulating means 19. The received pulse train or bit pattern is synchronized with an internal clock signal. The detecting means 21 further comprises a pulse length detecting circuit 44 connected to the synchronization circuit 43 via line 45. The output of the pulse length detecting circuit 44 is connected on its output side via line 46 to a register 47 for temporarily storing the received bit pattern. A bit comparator 48 connected to the register 47 via a line 49 compares the received bit pattern stored in the register 47 with the wake-up bit pattern stored in the memory 22 and increments a counter 51 via a control line 50, when the received bit pattern and the stored bit

pattern is identical. The wake-up command generating means 25 generates a wake-up command, when the counter 51 reaches an adjustable threshold value.

Fig. 8a shows a flow diagram of a method for establishing a data transfer link between the xDSL user modem 4 and the corresponding xDSL modem 9 in the central office 10 according to the present invention.

In a step S1, a wake-up bit pattern identifying the xDSL user modem 4 is generated by a bit pattern generating circuit 16.

In a step S2, the generated wake-up bit pattern is used for pulse length modulating an upstream data signal to generate a pulse length modulated wake-up signal by means of a modulating circuit 18.

The pulse length modulated wake-up signal is transmitted from the user xDSL modem 4 via the telephone line 8 to the xDSL modem 9 within the central office 10 in a step S3.

In a further step S4, the transmitted wake-up signal is demodulated by demodulating means 19 within the wake-up signal detection unit 12 of the xDSL modem 9.

In a step S5, the demodulated wake-up signal is compared with a wake-up bit pattern stored in the register 22.

In step S6, a wake-up command signal is generated when the received bit pattern is identical with the stored wake-up bit pattern, and the modem 11 is switched from a sleep mode to an operation mode to start a start-up procedure.

After the modem 11 has been switched into the operation mode, the xDSL modem 9 commences a start-up procedure to establish a data link with the corresponding xDSL user modem 4. After the start-up procedure, the normal data transfer is

performed. When the data transfer is finished, the xDSL modem 9 within the central office 10 is switched from the operation mode to the sleep mode.

Fig. 8b shows a preferred embodiment of step S6 within the main routine according to the present invention as shown in Fig. 8a. The received bit pattern stored temporarily in register 47 is compared to the wake-up bit pattern stored in register 22, and when both bit patterns are identicaly, counter 51 of comparing means 21 is incremented in a step S6-2. The value of the counter 51 is compared in step S6-3 with a predetermined threshold value, and a wake-up command signal is generated in step S6-4 when the counter reaches the threshold value. The wake-up command signal switches the xDSL modem 9 from the sleep mode to the operation mode.

List of reference numerals

1	xDSL data transfer system
2	data source
3	line
4	xDSL user modem
5	modem
6	line
7	wake-up signal generating circuit
8	telephone line
9	xDSL modem
10	central office
11	modem
12	wake-up signal detecting unit
13	line
14	line
15	cable
16	bit pattern generating means
17	line
18	half-length modulation circuit
19	demodulating means
20	line
21	comparing means
22	storing means
23	line
24	line
25	wake-up command generating means
26	train sequencer
27	rectifying means
28	low-pass filter
29	comparing means
30	operation amplifier
31	resistors
32	adjustable resistors
33	operational amplifier
34	switches
35	operational amplifier

36 resistor
37 resistor
38 resistor
39 capacitor
40 capacitor
41 line
42 operational amplifier
43 resistor
44 capacitor
43 synchronization means
44 pulse length detecting circuit
45 line
46 line
47 register
48 bit comparator
49 line
50 line
51 counter

Patent claims

1. Method for establishing a data transfer link between an xDSL user modem (4) and a corresponding xDSL modem (9) within a central office (10) comprising the following steps:
(a) generating (S1) a wake-up bit pattern identifying the user xDSL modem (4);
(b) pulse length modulating (S2) an upstream data signal with the generated wake-up bit pattern to generate a pulse length modulated wake-up signal;
(c) transmitting (S3) the pulse length modulated wake-up signal from the user xDSL modem (4) via a data transfer medium (8) to the xDSL modem (9) within the central office (10);
(d) demodulating (S4) the transmitted wake-up signal;
(e) comparing (S5) the modulated wake-up signal with a stored wake-up bit pattern for the detection of a transmission of the wake-up bit pattern from the xDSL user modem (4);
(f) generating (S6) a wake-up command signal, when the wake-up bit pattern is detected for switching the xDSL modem (11) within the central office (10) from a sleep mode to an operation mode for data transfer.

2. The method according to claim 1, wherein the xDSL modem (9) within the central office (10) commences a start-up procedure when it is switched to the operation mode.

3. The method according to claim 1, wherein the wake-up signal is transmitted periodically by the xDSL user modem (4).

4. The method according to one of the preceding claims, wherein the xDSL modem (9) within the central office (10) is switched from the operation mode to the sleep mode when the data transfer is finished.

5. The method according to one of the preceding claims, wherein a detection counter (51) is incremented when the wake-up bit pattern is detected.

6. The method according to one of the preceding claims, wherein the wake-up command signal is generated when the detection counter (51) reaches a threshold value.

7. The method according to claim 6, wherein the threshold value is adjusted.

8. An xDSL data transfer system for data transfer comprising at least one xDSL user modem (4) connected via a data transfer medium (8) to a corresponding xDSL modem (9) within a central office (10),
wherein the xDSL user modem (4) generates a pulse length modulated wake-up signal for switching the corresponding xDSL modem (9) within the central office (10) from a sleep mode to an operation mode.

9. The xDSL data transfer system according to claim 8, wherein the xDSL user modem (4) comprises
generating means (16) for generating a wake-up bit pattern identifying the xDSL user modem (4), and
modulating means (18) for the pulse length modulation of an upstream data signal with the wake-up bit pattern to generate the pulse length modulated wake-up signal,
wherein the pulse length modulated wake-up signal has a spectrum within the xDSL upstream frequency band.

10. The xDSL data transfer system according to one of the preceding claims, wherein the generated wake-up bit pattern comprises 16 bits.

11. The xDSL data transfer system according to one of the preceding claims, wherein each bit of the wake-up bit pattern

determines the duration of a pulse length of a pulse of the pulse length modulated wake-up signal.

12. The xDSL data transfer system according to one of the preceding claims, wherein the level of the wake-up signal is less than a predetermined maximum PSD-level.

13. The xDSL data transfer system according to one of the preceding claims, wherein the xDSL modem (9) within the central office (10) comprises:
demodulating means (19) for demodulating the received analog pulse length modulated signal;
storing means (22) for storing a wake-up bit pattern which identifies a corresponding xDSL user modem (4);
comparing means (21) for comparing the received demodulated signal with the stored wake-up bit pattern; and
wake-up command generating means (25) for generating a wake-up command to switch the xDSL modem (9) from the sleep mode to the operation mode, when the demodulated wake-up signal is identical with the stored wake-up bit pattern.

14. The xDSL data transfer system according to claim 13, wherein the demodulating means (19) of the xDSL modem (9) comprises a gain sequencer (26) for amplifying the received analog signal with an adjustable gain;
rectifying means (27) for rectifying the amplified signal;
a low-pass filter (28) for filtering the rectified signal; and
a comparator (29) for comparing the filtered signal with an adjustable threshold generating an asynchronous pulse train which is supplied to the bit pattern comparing means (21).

15. The xDSL data transfer system according to one of the preceding claims, wherein the bit pattern comparing means (21) comprises
a synchronization means (43) for synchronizing the asynchronous pulse train with an internal clock signal;

a pulse length detecting circuit (44) for detecting the pulse length of each pulse in the synchronized received pulse train and generating a logical bit value corresponding to the detected pulse length;
a register (47) for temporarily storing the received bit pattern;
a comparator (48) which compares the received bit pattern with the stored wake-up bit pattern and increments a counter (51), when the received bit pattern and the stored wake-up bit pattern is identical.

16. The xDSL data transfer system according to one of the preceding claims, wherein the wake-up command generating means (25) generates the wake-up command, when the counter (51) reaches an adjustable threshold value.

17. The xDSL data transfer system according to one of the preceding claims, wherein the xDSL modems (4, 11) are VDSL modems.

18. The xDSL data transfer system according to one of the preceding claims, wherein the data transfer medium (8) is a telephone line.

19. An xDSL user modem (4) comprising
a generating means (16) for generating a wake-up bit pattern identifying the xDSL user modem (4); and
modulating means (18) for the pulse length modulation of an upstream xDSL data signal with the generated wake-up bit pattern to generate a pulse length modulated wake-up signal, wherein the pulse length modulated wake-up signal has a frequency range within the xDSL upstream frequency band.

20. An xDSL modem (11) within a central office (10) comprising:
demodulating means (19) for demodulating a received analog pulse length modulated signal;

storing means (22) for storing a wake-up bit pattern identifying an xDSL user modem (4);

comparing means (21) comparing the received demodulated signal with the stored wake-up bit pattern;

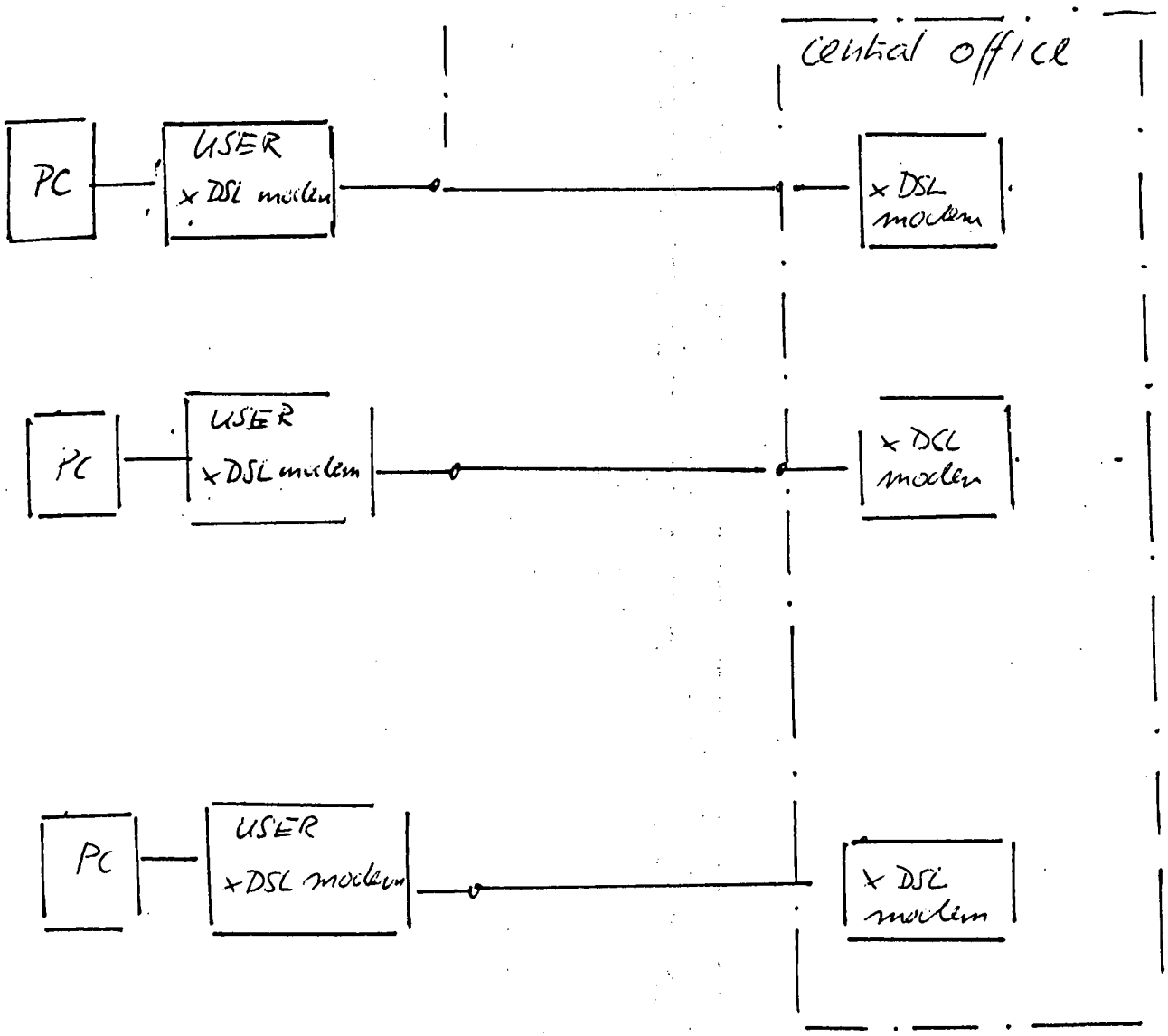
wake-up command generating means (25) for generating a wake-up command to switch the xDSL modem (9) from a sleep mode to an operation mode, when the received bit pattern is identical with the stored wake-up bit pattern.

Abstract

System and method for establishing an xDSL data transfer link

An xDSL data transfer system for data transfer comprising at least one xDSL user modem (4) connected via a data transfer medium (8) to a corresponding xDSL modem (9) within a central office,
wherein the xDSL user modem (4) generates a pulse length modulated wake-up signal for switching the corresponding xDSL modem (9) within the central office (10) from a sleep mode to an operation mode.

Fig. 2



1/9

State of the art

FIG. 1

2-1
3-1
5-1
4-1
6-1
7-1
2-2
3-2
5-2
4-2
6-2
7-2
2-N
3-N
5-N
4-N
6-N
7-N
8-1
8-2
8-N
15
13-1
11-1
12-1
9-1
10
13-2
11-2
12-2
9-2
14-1
13-N
11-N
12-N
9-N
14-N

Fig. 2

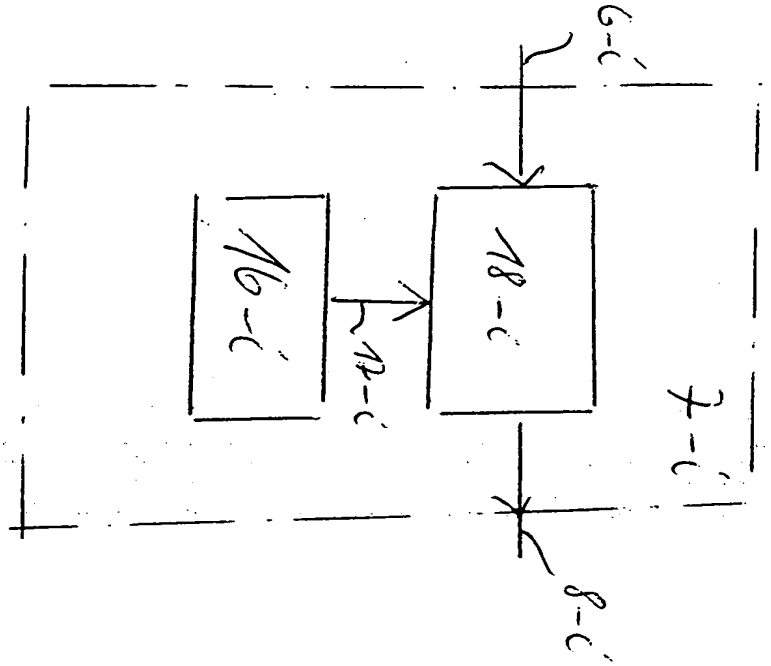


Fig 3

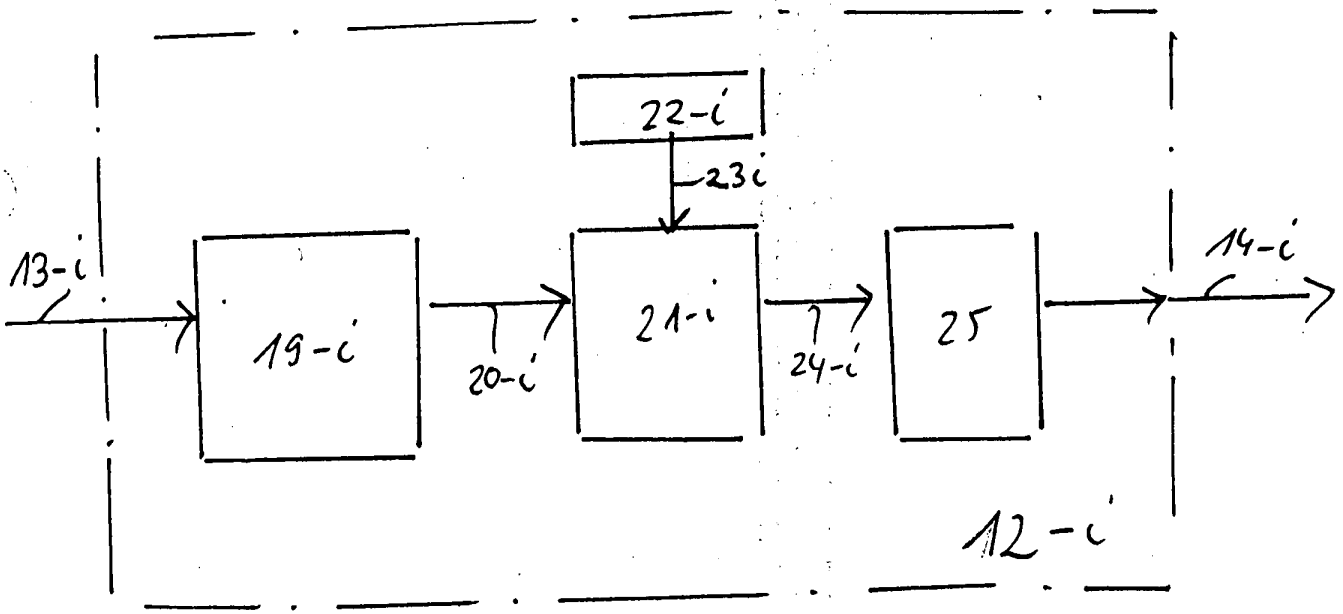


Fig 4

Fig. 5

Fig 6

Fig. 1

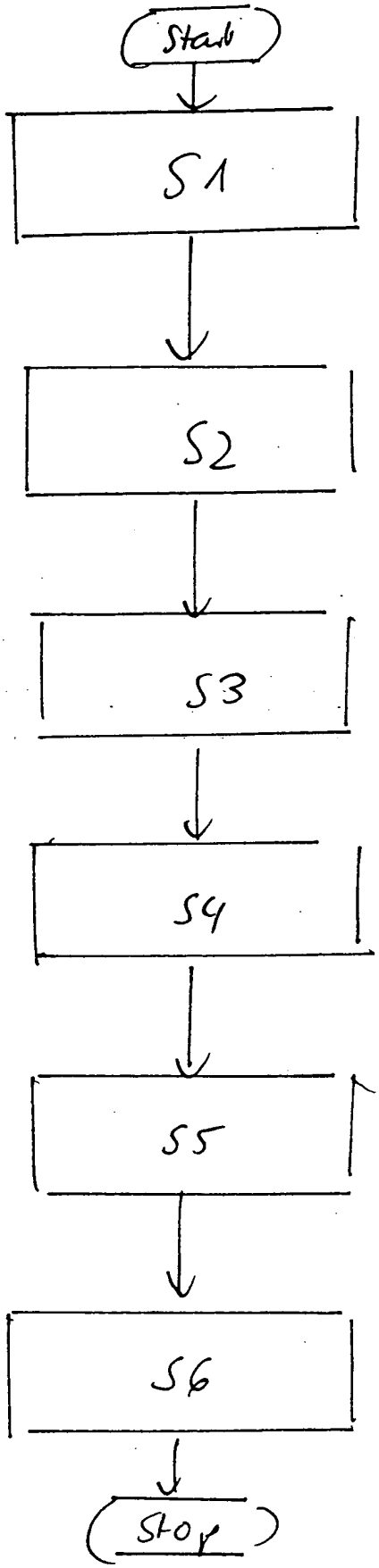


Fig 8a

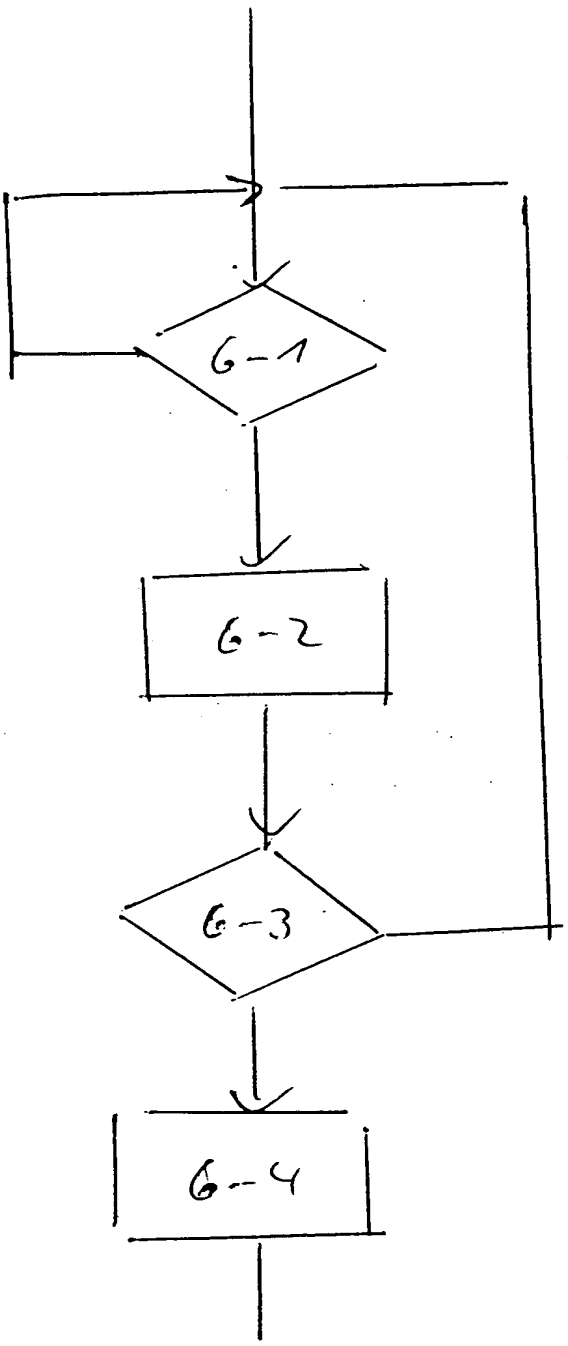


Fig 8b